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THE EFFECT OF GREEN FERTILIZERS IN THE FORM OF CATCH CROPS ON SOIL HUMIDITY CHANGES IN A THREE-YEAR-LONG VEGETABLE CROP ROTATION

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ABSTRACT

A field experiment was conducted in central-eastern Poland in the years 1999-2003. It analyzed the effect of catch crop green fertilizers on soil humidity in a three-year-long crop vegetable rotation (white cabbage, onion, red beet). Oats, field pea and spring vetch cultivated in pure sowing and as mixtures were used as green fertilizers. The effect of green manures was compared with ploughed in farmland manure in the dose of 25 $t \cdot ha^{-1}$ and the control without any organic fertilization. White cabbage was grown in the first year after organic fertilization, onion – in the second and red beet – in the third.

Key words: organic fertilization, green manures, soil humidity, white cabbage, onion, red beet.

INTRODUCTION

Intensification of plant production accelerates mineralization of the organic matter. This leads to a permanent decrease of the amount of humus in the soil. Humus conglomerates the soil particles, giving them the proper structure. Owing to this, the soil can accumulate a sufficient amount of water but also of air [9]. In order to keep the amount of humus at a proper level it is necessary to introduce organic matter into the soil in a systematic way. Green manures constitute an easily accessible source of this matter [5, 6].

Stubble and winter intercrops are the most frequently used forms of green fertilization, while a catch crop form of green manures is a less popular form of catch crops. The effect of green manures is largely dependent on the course of the weather, and especially the amount and distribution of atmospheric falls, which for example affect the mineralization rate of the organic matter and water relations in the soil [4].

The use of green manures can affect a drop of soil humidity, especially in the first year after ploughing in. According to Borna [2, 3], catch crops are the form of green fertilization that dry up the soil the most.

METHODS

The field experiment was done in the years 1999-2003 in the area of the Agricultural Experimental Station at Zawady, a part of the Podlasie University. It was established in a split-block scheme in three repetitions. The experiment was conducted in three stages. Each included the cultivation of catch crop plants intended as green manures, the cultivation of white cabbage, onion and red beet.

The experiment was carried out on grey brown podzolic soil with the mean humus content of 1.7% and pH in H_2O at the level of 5.9. The experiment examined the changes of soil humidity in the cultivation of vegetables depending on the type of the applied organic fertilization.

The effect of two factors was analyzed: A – the form of ploughing in the catch crops as the green manure, B – the kind of organic fertilization. Oats, field pea, spring vetch and mixtures of these plants were used as green manure. Two forms of using the catch crops as green manure were applied – the whole plant biomass and the crop residues, which were the roots with a 5-cm stubble. The effect of green manures was compared with farmyard manure fertilization in the amount of 25 $t \cdot ha^{-1}$ and the control object without organic fertilization. The dimensions of the plot of organic fertilization were 36 m^2, and the total number of plots was 54.

Plants for green manure were sown at the turn of March and April, and they were ploughed in during the first days of June. Immediately before the catch crops were ploughed in, their samples were taken from the area of 1 m^2 with the aim of determining the fresh and dry weight of the overground parts of plants and the weight of crop residues. Besides, farmyard manure was sampled in order to establish the dry weight content.

White cabbage was cultivated in the first year after ploughing in the organic fertilizers, onion – in the second, and red beet – in the third. In order to determine the changes of soil humidity in successive years after ploughing in the organic matter, soil samples were taken from the soil layer of 0-30 cm from all combinations of fertilization into hermetically closed containers. The samples were taken 7-10 days before ploughing in the organic fertilizers and 7-10 days before the harvest of cabbage, onion and red beet. Soil humidity was determined by the drier-gravimetric method. The course of the amount and distribution of atmospheric falls was observed during the experiment.

The results were statistically analyzed using variance analysis proper to the split-block model. The significance of differences between the mean values was established by Tukey's test at the significance level of $p = 0.05$.

RESULTS

Climatic conditions of studies

The eastern part of the Mazovian district is characterized by a typical Polish transition, warm, sea but continental climate. The area where the Agricultural Experimental Station at Zawady lies is situated within the range of the eastern soil-climatic region. The length of the vegetative period is 200-210 days. The greatest amount of atmospheric falls is observed in summer. The mean yearly sum of rainfalls is about 550 mm.

In all the years the studies found out the sums of atmospheric falls lower than the means of many years (tab. 1). The year 2003 was very dry and then the annual sum of rainfalls was by 293.3 mm lower than the many years' means for the years 1951-1990. The greatest amount of rainfalls during the five years of the experiment was found in 2000, namely 457 mm.

Table 1. Monthly sum sums of atmospheric falls (mm) during the studies according to the Meteorological Stadion at Zawady

Years	Months												Sum	Sum of rainfall during the vegetation			
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII		catch crops IV-V	cabbage VI-X	onion IV-IX	red beet VI-IX
1999	2.9	3.8	14.3	87.3	26.4	121.7	21.9	77.4	27.8	11.6	32.0	13.6	440.7	113.7	260.4	-	-
2000	5.8	24.5	19.2	47.5	24.6	17.0	155.9	43.6	61.1	3.2	32.6	22.0	457.0	72.1	280.8	349.7	-
2001	19.9	9.4	3.6	69.8	28.0	36.0	55.4	24.0	108.0	28.0	28.0	13.4	423.5	97.8	251.4	321.2	251.4
2002	8.7	37.5	15.8	12.9	51.3	61.1	99.6	66.5	18.7	48.9	16.1	0.7	437.8	-	-	310.1	294.8
2003	7.7	4.7	7.0	13.6	37.2	26.6	26.1	4.7	24.3	38.0	14.7	17.0	221.6	-	-	-	81.7
Means of many years 1951-1990	24.5	23.3	27.0	29.4	54.3	69.3	70.6	59.8	48.2	32.0	39.2	37.3	514.9	83.7	279.9	331.6	247.9

The year 1999 was the best as regards the humidity conditions in the period of the vegetation of catch crops. The observed sum of rainfalls in April-May was higher by 30 mm in relation to the means of many years for that period. The year 2000 was the worst. The sum of rainfalls in the period of growth of catch crops was 72.1 mm and it was lower than the means of many years by 11.6 mm.

The years 2000, when between June and October 280.8 mm of rain fell, turned out to be the best as regards the humidity conditions. That value was insignificantly higher than the means of many years for that period. The smallest amount of rainfalls in the period of cabbage growth (251.4 mm) was found in 2001.

The greatest amount of atmospheric falls in the period of onion vegetation was observed in 2000 (by 18.1 mm higher than the means of many years). In 2001 the studies observed a very uneven distribution of rainfalls – dry May, June, July and August came after wet April, while September was very wet, with the rainfalls exceeding the means of many years by 59.8 mm. The year 2002 was characterized by the lowest sum of atmospheric falls in the period of onion vegetation; however, their distribution in relation to 2000 and 2001 was more even.

In the period of vegetation of red beet the sum of rainfalls in 2001 was close to the means of many years for that period and it was 294.8 mm. The year 2002 turned out the best as regards the distribution of atmospheric falls. Their big amounts in May and June, close to the means of many years, contributed to the accumulation of considerable resourced of humidity in the soil. The rainfalls of July and August (99.6 mm and 66.5 mm, respectively) had a very good effect on humidity relations in the soil. Only 81.7 mm of rainfalls was observed in a very dry year of 2003 in the period between June and September, which was by 166.2 mm less as compared to the many years' means of that period. The amount and distribution of rainfalls affected the content of humidity in the soil.

The amount of fresh and dry weight introduced into the soil with organic fertilizers

Catch crops cultivated for green manures differed between each other as regards the amount of the plant weight and the quantity of the crop residues (tab. 2).

Table 2. The Mount of the fresh and dry weight (t·ha-1) ploughed in with catch crops – means of 1999-2001

Kind of green manure	Whole plants		Crop residues	
	fresh weight	dry weight	fresh weight	dry weight
Oat	34.80	6.32	14.25	3.24
Field pea	14.91	1.90	3.89	0.59
Oats + field pea	29.89	4.38	8.85	1.50
Spring vetch	15.24	2.10	5.10	0.84
Vetch + oats	24.84	3.83	6.29	1.23
Vetch + field pea	10.99	1.64	2.61	0.45
Vetch + oats + field pea	24.55	4.43	7.68	1.67
$LSD_{0.05}$	3.46	0.69	1.06	0.58

The greatest amount of biomass was introduced into the soil with oats (34.80 $t \cdot ha^{-1}$ fresh weight). That amount was significantly higher than that which was found in the case of the other catch crops. A high yield of fresh weight was also characteristic of the mixtures of: oats and field pea (29.89 $t \cdot ha^{-1}$ f.w.), vetch and oats (24.84 $t \cdot ha^{-1}$ f.w.) and vetch with oats and field pea (24.55 $t \cdot ha^{-1}$ f.w.). Three times as much organic mass was ploughed in with green manures from oats and the mixture of oats with field pea as from the mixture of vetch with field pea (10.99 $t \cdot ha^{-1}$ f.w.) and twice as much as with field pea (14.91 $t \cdot ha^{-1}$ f.w.) and spring vetch (15.24 $t \cdot ha^{-1}$ f.w.) in pure sowing. The mixtures of oats with field pea and vetch with oats and field pea formed one and a half to twice as much biomass than field pea and spring vetch in pure sowing and in a mixture.

A similar relation was found in the amount of crop residues. Significant differences were observed between all catch crops in the mass of the ploughed in stubble and roots. The greatest amount of organic matter was introduced into the soil with oats residues (14.25 $t \cdot ha^{-1}$ f.w.), half as much – with the resides of the mixtures of oats with field pea (8.85 $t \cdot ha^{-1}$ f.w.), vetch with oats and field pea (7.68 $t \cdot ha^{-1}$ f.w.) and vetch with oats (6.29 $t \cdot ha^{-1}$ f.w.). The smallest amount of resides was left in the field by the mixtures of vetch with field pea (2.61 $t \cdot ha^{-1}$ f.w.) and field pea in pure sowing (3.89 $t \cdot ha^{-1}$ f.w.). The fresh weight of crop residues of spring vetch was 5.10 $t \cdot ha^{-1}$ f.w.). 6.40 $t \cdot ha^{-1}$ dry weight was introduced with farmyard manure in the quantity of 25 $t \cdot ha^{-1}$. A

comparable amount (6.32 t·ha^{-1} d.w.) was ploughed in with the whole plants of oats. The dry weight yield of the mixture of oats with vetch and field pea and the mixture of oats with field pea was similar and it was 4.43 t·ha^{-1} d.w. and 4.38 t·ha^{-1} d.w., respectively. The smallest amount of dry weight with the whole plants was introduced into the soil with field pea (1.90 t·ha^{-1} d.w.) and its mixture with spring vetch (1.64 t·ha^{-1} d.w.). 2.10 t·ha^{-1} d.w. was ploughed in with the whole plants of spring vetch catch crop, and 3.83 t·ha^{-1} d.w. – with the mixture of vetch with oats.

The greatest amount of dry weigh introduced with crop residues came from oats (3.24 t·ha^{-1} d.w.). By about 50% less dry weight was ploughed in with the residues of the following mixtures: oats with field pea, vetch with oats as well as vetch with oats and field pea (from 1.23 t·ha^{-1} d.w. to 1.67 t·ha^{-1} d.w.). The least dry weight was introduced into the soil with field pea and a mixture of vetch with field pea (0.59 t·ha^{-1} d.w. and 0.45 t·ha^{-1} d.w.).

Soil humidity

Before the ploughing in of catch crop plants. The humidity of the soil itself as well as variable weather conditions (mainly the distribution and amount of rainfall) affected the soil humidity before the ploughing in of catch crop plants in the successive years of studies (tab. 3). The highest humidity (10.92%) was observed for the soil in 1999, slightly lower (10.70%) in 2001 and significantly the lowest (8.89%) in the years 2000.

The studies found out a tendency for a slight increase of the humidity of the soil sown with catch crops as compared with the control soil and the soil intended for farmyard manure fertilization. However, those differences were not statistically proved.

Before cabbage harvest. Humidity of the plough layer of the soil (0-30 cm) before cabbage harvest was differentiated in particular years of studies (tab. 4). The highest (13.79%) was observed in 2001, lower (11.03%) in 2000, while the lowest (10.23%) in 1999. In the year 2001 September rainfalls supplemented the water reserves in the soil and considerably increased its humidity as compared to the period when catch crops grew. In 2000 very heavy rainfalls of July (155.9 mm) and the rainfalls of August and September that were close to the means of many years caused that soil humidity before the cabbage harvest was also higher like before the ploughing in of catch crops. In the middle of October of 1999 soil humidity remained at a similar level as before the ploughing in of catch crops.

The kind of the applied organic fertilization had an effect on soil humidity in cabbage cultivation. The highest humidity (12.49%) was observed for the control soil without organic fertilization with ploughed in green manure from field pea (12.40%). Similar humidity was found on the combinations fertilized with farmyard manure (12.06%) and green manures from vetch (12.05%) and a mixture of vetch with field pea (12.21%). As compared with the soil fertilized with farmyard manure, a significantly lower humidity was characteristic of the soil with ploughed in oats (10.54%) and its mixture with field pea (10.65%). The soil after ploughing in the catch crops from oats, a mixture of oats with field pea, a mixture of vetch with oats and a mixture of vetch with oats and field pea had a significantly lower humidity than the control without organic fertilization.

The effect of the kind of organic fertilization on soil humidity in the cultivation of cabbage depended on the form of ploughing in the green manures. A greater decrease of soil humidity was found out after ploughing in catch crops as whole plants as compared to ploughing in the crop residues themselves.

Ploughing in oats as whole plants, a mixture of oats with field pea, a mixture of vetch with oats and a mixture of vetch with oats and field pea contributed to a significant decrease of soil humidity in relation to the control, which was not organically fertilized and to farmyard manure fertilization. Lower humidity than the control without organic fertilization was also observed in the soil after ploughing in vetch. Humidity of the soil fertilized with farmyard manure and with the whole plants of field pea, vetch and a mixture of those plants remained at a similar level.

Table 3. Soil humidity (%) before ploughing in catch crops

Organic fertilization	Years									Mean for the form of ploughing in the catch crop		Mean for organic fertilization
	1999			2000			2001					
	NK*	K**	Mean	NK*	K**	Mean	NK*	K**	Mean	NK*	K**	
Control	11.14	11.22	11.18	8.49	8.61	8.55	9.65	9.80	9.72	9.76	9.88	9.82
Farmyard manure	10.94	10.77	10.86	8.39	8.44	8.42	9.80	9.84	9.82	9.71	9.69	9.70
Oats	10.12	10.19	10.15	9.42	9.15	9.29	11.11	11.20	11.16	10.21	10.18	10.20
Field pea	11.71	11.81	11.76	8.90	8.87	8.88	11.44	11.08	11.26	10.68	10.59	10.64
Oats + field pea	10.31	10.46	10.39	9.28	9.26	9.27	10.83	10.55	10.69	10.14	10.09	10.12
Spring vetch	10.58	11.56	11.07	9.11	8.98	9.04	10.94	10.80	10.87	10.21	10.45	10.33
Vetch + oats	10.26	10.30	10.28	9.04	8.88	8.96	11.16	11.27	11.21	10.15	10.15	10.15
Vetch + field pea	11.62	11.43	11.53	8.63	8.64	8.63	10.46	10.01	10.24	10.24	10.03	10.13
Vetch + oats + field pea	9.73	12.34	11.03	8.87	9.11	8.99	11.38	11.30	11.34	9.99	10.91	10.45
Mean	10.71	11.12	10.92	8.90	8.88	8.89	10.75	10.65	10.70	10.12	10.22	10.17
$LSD_{0.05}$ for years = 0.49												

*NK – ploughed in whole biomas sof green manures
**K – ploughed in crop residues of green manures

Table 4. Soil humidity (%) before the harvest of white cabbage

Organic fertilization	Years									Mean for the form of ploughing in the catch crop		Mean for organic fertilization
	1999			2000			2001					
	NK*	K**	Mean	NK*	K**	Mean	NK*	K**	Mean	NK*	K**	
Control	11.32	11.24	11.28	11.72	11.69	11.70	14.50	14.44	14.47	12.52	12.46	12.49
Farmyard manure	9.97	10.04	10.01	11.60	11.54	11.57	14.64	14.58	14.61	12.07	12.05	12.06
Oats	8.50	10.12	9.31	8.93	10.71	9.82	11.42	13.53	12.48	9.62	11.45	10.54
Field pea	10.95	11.29	11.12	11.17	11.89	11.53	14.08	15.01	14.55	12.07	12.73	12.40
Oats + field pea	9.07	9.73	9.40	9.22	10.63	9.93	11.17	14.05	12.61	9.82	11.47	10.65
Spring vetch	9.97	10.54	10.26	11.10	12.01	11.55	13.40	15.30	14.35	11.49	12.62	12.05
Vetch + oats	9.95	9.52	9.74	10.00	11.44	10.72	12.88	14.44	13.66	10.94	11.80	11.37
Vetch + field pea	10.14	11.13	10.64	11.19	11.53	11.36	13.74	15.55	14.64	11.69	12.74	12.21
Vetch + oats + field pea	9.15	11.46	10.30	10.19	11.92	11.06	11.47	13.96	12.71	10.27	12.44	11.36
Mean	9.89	10.56	10.23	10.57	11.48	11.03	13.03	14.54	13.79	11.17	12.20	11.68
$NIR_{0.05}$ for: years = 0.52, form of ploughing in = 0.34; kind of fertilization = 0.98; in interaction: form of ploughing in × kind of fertilization = 0.97												

*NK – ploughed in whole biomas of green manures (unscythed sub-block)
**K – ploughed in crop residues of green manures (scythed sub-block)

After introducing catch crop residues themselves into the soil, a significant decrease of soil humidity as compared with the control was observed only after oats and a mixture of oats with field pea. The use of green manures in the form of crop residues in cabbage cultivation did not have any significant effect on a change of soil humidity as compared to the applied farmyard manure.

Before onion harvest. Onion was cultivated in the second year after ploughing in organic fertilizers. Soil humidity determined before the harvest varied in particular years (tab. 5). The highest humidity (16.59%) was found for the soil in 2001, while the lowest (12.12%) – in 2002. Those differences were caused by the amount and distribution of rainfall in successive years. September rain in 2001, which more than twice exceeded the means of many years, caused a considerable increase of soil humidity as compared with the years 2000 and 2002. The kind of the applied organic fertilization had an effect on soil humidity in cabbage cultivation. In the second year after ploughing in the organic matter got partly decomposed and it did not have a negative effect on soil humidity any more. When green manures of field pea, vetch and a mixture of those plants were ploughed in, a significant increase of soil humidity was observed as compared to the control without organic fertilization. That increase was 1.72%, 1.51% and 1.44%, respectively. The enumerated green manures had a significantly better effect on soil humidity than green manures of oats and a mixture of oats with field pea. In comparison with farmyard manure, green manures did not have a significant effect on soil humidity.

The form of ploughing in green manures and the interaction of the studied factors did not have any significant effect on the changes of soil humidity in the cultivation of cabbage in the second year after ploughing in.

Before red beet harvest. Soil humidity before the harvest of red beet was affected by weather conditions in particular years of studies (tab. 6). The highest humidity (12.69%) was characteristic of the soil in 2002. In 2001 soil humidity was lower by 2.15%, while in 2003 – by 6.36%, and it was at the level of 6.33%. The year 2003 was characterized by a deficit of rainfall. In that year the sum of atmospheric rainfall during the period of red beet vegetation was only 33% of the many-years' mean from the years 1951-1990. It had a significant effect on worse water relations in the soil.

A positive effect of green manures on soil humidity was observed in the third year after ploughing in. The soil, where the whole mass of catch crop organic mass was introduced, was characterized by a significantly higher humidity than the soil fertilized with crop residues. Increased humidity of the surface layer of the soil under the effect of catch crops ploughed in as whole plants was observed in each year of red beet cultivation. Catch crops ploughed in as whole plants significantly affected increased humidity of the soil as compared with the control without organic fertilization. Introducing the whole biomass of oats, spring vetch, a mixture of oats with field pea and a mixture of vetch with field pea caused a significant increase of its humidity as compared to the effect of ploughed in farmyard manure. Ploughing in field pea, a mixture of vetch with oats and a mixture of vetch with oats and field pea did not cause any significant changes in soil humidity as compared with farmyard manure.

Ploughing in crop residues of spring vetch, a mixture of vetch with oats and a mixture of vetch with oats and field pea had a significant effect on increased humidity of the soil as compared to the control without organic fertilization. In comparison to farmyard manure, only ploughing in the crop residues of a mixture of vetch with field pea had a significant effect on decreased soil humidity.

Table 5. Soil humidity (%) before onion harvest

Organic fertilization	Years									Mean for the form of ploughing in the catch crop		Mean for organic fertilization
	2000			2001			2002					
	NK*	K**	Mean	NK*	K**	Mean	NK*	K**	Mean	NK*	K**	
Control	13.01	12.97	12.99	15.59	15.47	15.53	11.17	11.12	11.15	13.26	13.19	13.22
Farmyard manure	12.90	12.86	12.88	17.10	17.00	17.05	11.76	11.70	11.73	13.92	13.85	13.89
Oats	12.20	12.94	12.57	15.64	15.92	15.78	11.31	11.82	11.57	13.05	13.56	13.31
Field pea	14.38	14.39	14.38	17.64	17.39	17.52	12.88	12.94	12.91	14.97	14.91	14.94
Oats + field pea	11.92	12.39	12.16	15.45	15.91	15.68	11.03	12.09	11.56	12.80	13.46	13.13
Spring vetch	13.47	13.16	13.32	16.82	18.21	17.52	13.43	13.28	13.35	14.57	14.88	14.73
Vetch + oats	13.02	12.22	12.62	15.88	16.68	16.28	12.78	12.63	12.71	13.89	13.85	13.87
Vetch + field pea	13.64	14.11	13.87	16.94	17.44	17.19	12.85	12.98	12.92	14.48	14.84	14.66
Vetch + oats + field pea	12.04	14.64	13.34	16.98	16.61	16.80	11.03	11.40	11.22	13.35	14.22	13.78
Mean	12.95	13.30	13.13	16.45	16.74	16.59	12.03	12.22	12.12	13.81	14.08	13.95
$NIR_{0.05}$ for: years = 0.47; kind of fertilization = 1.16												

*NK – ploughed in whole biomas sof green manures (unscythed sub-block)
**K – ploughed in crop residues of green manures (scythed sub-block)

Table 6. Soil humidity (%) before the harvest of red beet

Organic fertilization	Years									Mean for the form of ploughing in the catch crop		Mean for organic fertilization
	2000			2001			2002					
	NK*	K**	Mean	NK*	K**	Mean	NK*	K**	Mean	NK*	K**	
Control	9.56	9.43	9.49	11.55	11.21	11.38	5.09	5.13	5.11	8.74	8.59	8.66
Farmyard manure	10.51	10.23	10.37	12.41	12.49	12.45	6.34	6.27	6.31	9.76	9.66	9.71
Oats	11.68	9.58	10.63	14.02	11.49	12.76	7.36	6.64	7.00	11.02	9.24	10.13
Field pea	10.57	9.52	10.05	12.68	11.43	12.06	6.49	6.04	6.26	9.91	9.00	9.46
Oats + field pea	11.85	9.77	10.81	14.05	11.80	12.93	6.92	6.10	6.51	10.94	9.22	10.08
Spring vetch	12.13	10.42	11.28	14.55	12.51	13.53	6.38	5.86	6.12	11.02	9.60	10.31
Vetch + oats	11.49	10.92	11.20	13.45	13.60	13.53	6.62	6.53	6.57	10.52	10.35	10.43
Vetch + field pea	12.02	8.29	10.16	14.42	10.62	12.52	6.40	5.56	5.98	10.95	8.16	9.55
Vetch + oats + field pea	11.04	10.69	10.86	13.29	12.85	13.07	7.34	6.90	7.12	10.56	10.14	10.35
Mean	11.21	9.87	10.54	13.38	12.00	12.69	6.55	6.11	6.33	10.38	9.33	9.85
$NIR_{0.05}$ for: years = 0.26; form of ploughing in = 0.17; kind of fertilization = 1.49; in interaction: years × form of ploughing in = 0.30; form of ploughing in × kind of fertilization = 0.92												

*NK – ploughed in whole biomas sof green manures (unscythed sub-block)
**K – ploughed in crop residues of green manures (scythed sub-block)

DISCUSSION

In the period of vegetation of vegetables soil humidity underwent considerable changes caused by the amount and distribution of atmospheric falls as well as the effect of the studied experimental factors. In the cultivation of catch crops for green manure a danger appears of exhausting the resources of humidity in the soil, especially in the years with little rainfall. According to Borna [2, 3], catch crops are the form of green manures that cause the least positive changes in water relations in the soil. Also Songin [12] emphasizes that the cultivation of intercrops in dry years can have negative consequences, leading to disturbances in the soil water balance.

The studies found out that catch crops of oats and its mixture with field pea exhausted the soil humidity the most. In cabbage cultivation the soil after those green manures was characterized by a considerably lower humidity than after ploughing in farmyard manure. Oats and a mixture of oats with field pea formed the greatest amount of biomass among the discussed catch crops, in this way drying up the soil in the greatest degree. Additionally, a considerable amount of ploughed in biomass reduced the upward water movement from deeper layers of the soil. A similar relation between the amount of the green mass formed by fertilizer plants and soil drying up after ploughing it in was found out by Borna [2] and Zaniewicz [13].

In the following years the ploughed in organic mass got partly decomposed and no negative effect was found on soil humidity. Increased humidity was also observed after applying certain green manures as compared to the control without organic fertilization. A similar relation after ploughing in the catch crops was also found out by Borna [1, 3]. Zaniewicz [13], Franczuk et al. [8] and Franczuk [7] observed an increase of soil humidity in the second and third years after ploughing in green manures in the form of stubble and winter intercrops. A positive consecutive effect of intercrops of oats and vetch applied as mulch on soil humidity was found out by Konopiński et al. [11] and Konopiński [10].

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